OCCURRENCE OF CARBONACEOUS MATERIAL IN THE GREENFIELD MEMBER OF THE MONROE FORMATION.

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At the Rucker quarries in Greenfield in southwestern Ohio, is the largest and most important exposure of this member in the Monroe formation. Above the water level of Paint Creek there are 45 feet of stone, and quarrying has been conducted as deep as 15 feet below this level. The entire vertical extent, which is of the Greenfield member, is 60 feet. The rock is a dolomitic limestone and is divided into two parts, the lower strata gray and the upper ones buff. The gray is a hard, solid limestone, while the buff, although firm, breaks more easily under the hammer. In addition to the color the occurrence of carbonaceous material also serves to differentiate the two parts. The Greenfield stone is of a very close texture and with the exception of occasional masses having crevices, its firmness, solidity and density are distinguishing characteristics. The stone is rich in carbonaceous material which is disseminated throughout its entire extent, as it has little opportunity to collect in any large quantity. When the stone is freshly broken this material gives it a bituminous odor which is a helpful test in distinguishing this rock from other formations.

The Gray Stone.—In the gray stone carbonaceous material is evidenced in three ways in addition to the odor test.

First.—In a thin ledge within a foot of its lowest worked level this carbonaceous material is volatile. As pieces are broken off it evaporates much the same as gasoline when poured out.

Second.—Throughout the gray stone carbonaceous material manifests itself by the profusion of carbon lines. They are as numerous as twenty or twenty-five to the inch. Their size is similar to that of lines drawn with a fine pen point. They do not occur at regular intervals; one inch will be full of them, then a clear space of a fractional part of an inch, then more lines. When they occur close together at intervals, they give the rock the appearance of having a banded structure. Usually they are parallel, and not often wavy unless bending around a quartz-lined cavity or a nodule of sphalerite. The

rock can be split along these lines and the surfaces will show hard, dry, carbonaceous material either solid in extent or in patches. In the gray stone these lines are all through it, while in the buff stone the few that occur are usually found near the edges of the ledges.

Third.—Carbonaceous material also occurs in the gray stone in sheets. These sheets occur at the parting line between the ledges, especially between the strata near the contact between the buff and the gray stone. Particularly after blasting these sheets can be taken out entire as large as two feet square. The average thickness is almost 1/32 inch, and they are sometimes as thick as 1/16 inch. When these sheets are placed in the fire they burn with an oily, sooty flame, leaving a thin rock stratum. The sheets are not consumed as a shingle would be, but the carbonaceous material seems to burn out as if the sheet were soaked in oil. This suggests that these sheets are very thin limestone layers heavily impregnated with carbonaceous material.

When these carbon dividing planes of the lower layers are split they often show the obverse and reverse of the fossil plant, **Sphaerococcites** (?) **glomeratus** Grabau. It is a ready inference that these sheets and lines mark the beds of this plant, from the decay of which they received their carbon material. The objection that the lines are often noticed in the buff stone where this fossil plant is not found can be met by the statement that as the lines are thickest and most profuse in the gray stone there would be the most natural place for the distinctive preservation of the fossil. Further, the harder texture of the gray stone which prevents the carbonaceous material from penetrating the rock would also serve to preserve the fossil plant distinctively and in its entirety. It also suggests that the gray stone was built up by successive flourishing of the plant and deposition of rock material. As the gray stone is hard and very solid, we do not find carbonaceous material other than as just stated, as it has no opportunity to seep through the rock and collect in masses of "rock tar."

The Buff Stone.—The buff stone being softer, less dense and with numerous cavities, its carbonaceous material has the opportunity to present itself more distinctly than in the gray stone. While carbon lines do occur, yet they are never in profusion

and are to be found in only a few strata other than have been mentioned. The buff stone is most carbonaceous where it is nearest the gray. The odor test indicates that the buff stone is equal to the gray in its carbon element. It also manifests itself in three additional ways.

First.—In breaking the buff stone we frequently find that its looser texture has permitted the carbonaceous material to gather between the rock particles. The stone appears as though stained with some heavy black oil or fluid.

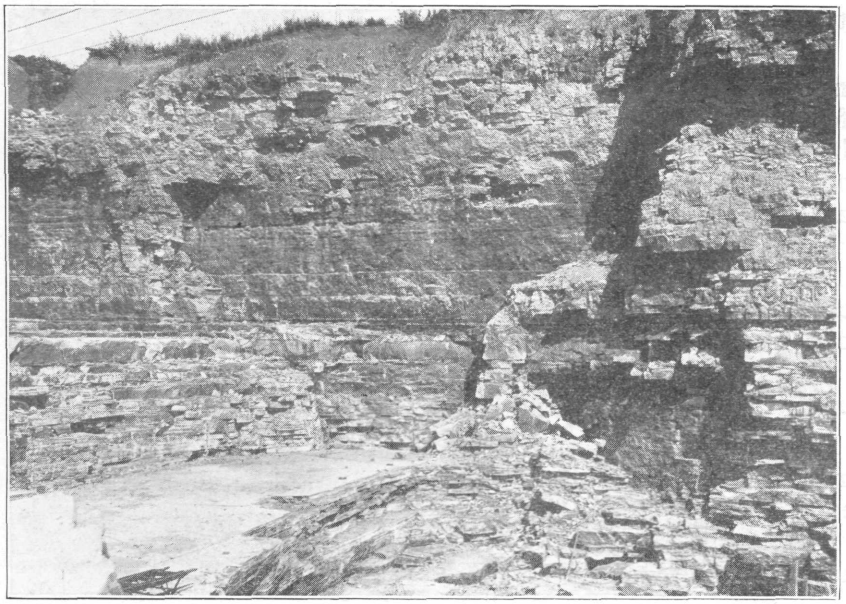

FIG. 1. The Greenfield member of the Monroe formation, Rucker quarries, Greenfield, Ohio.

1. Drift.
2. Buff stone, with heavy layers and carbon sheet zone toward the base.
3. Gray stone, with carbon lines.

Second.—Carbon sheets are more frequent and better defined in the buff than in the gray stone. They occur between the lower ledges; in fact, from two feet below to six or eight feet above the contact of the gray and buff stones is the carbon sheet zone. There seems to be a gradation from the profuse carbon lines of the gray stone to their total absence in nearly all of the buff. The dominant distinguishing feature of the

buff stone in this particular exposure is the almost complete absence of carbon lines, which causes it to stand out in strong contrast to the gray stone with its profusion of these lines.

Third.—Throughout the buff stone of this particular exposure, but especially numerous in its heavier lower ledges, occur "cup and cone concretions." These peculiar forms are fully treated in another paper, but for the present study the cavity usually present with them affords the best place for the collection of carbonaceous material. These "concretions" do not occur in the gray stone, and it seems that the looser texture of the buff stone favors their formation.

From the rock surrounding the cavities the carbonaceous material drains into them. Here the natural "rock tar" is found. Sometimes it spreads out and fills the cavity; sometimes it adheres to the walls of the cavity in drops as large as the end of the little finger. This is pure, solid carbon material, hardened and brittle; when heated it becomes waxy and burns with a heavy, oily flame. While a rare form, Figure No. 3 admirably illustrates how this collection does take place. The drop in the cavity at the termination of a carbon line along which has been the flow is conclusive evidence. Also on the sides of the "cup and cone concretions" are lines of fracture where carbonaceous material accumulates. Here it appears in streaks.

Summary.—The Greenfield member of the Monroe formation contains much carbonaceous material, evidenced by odor, carbon sheets and lines, carbon stains, and solidified "rock tar." Its close texture prevents that accumulation necessary for a paying gas or oil rock. If its texture were open and spongy then it might have had economic value other than that for building and agricultural purposes.

EXPLANATION OF PLATE.

FIG. 1. Occurrence of carbonaceous material in gray stone. "Carbon sheets" occur between layers nearest contact with buff stone in which they are far more numerous. "Carbon lines" are profuse throughout the gray stone and serve to distinguish it.

FIG. 2. Occurrence of carbonaceous material in buff stone. Upper layer stained with carbon material; lower layer to show collection in cavities and in "cup and cone" concretions.

FIG. 3. "Rock tar" in buff stone. Collection and flow have been along carbon line, terminating in carbon drop in cavity.

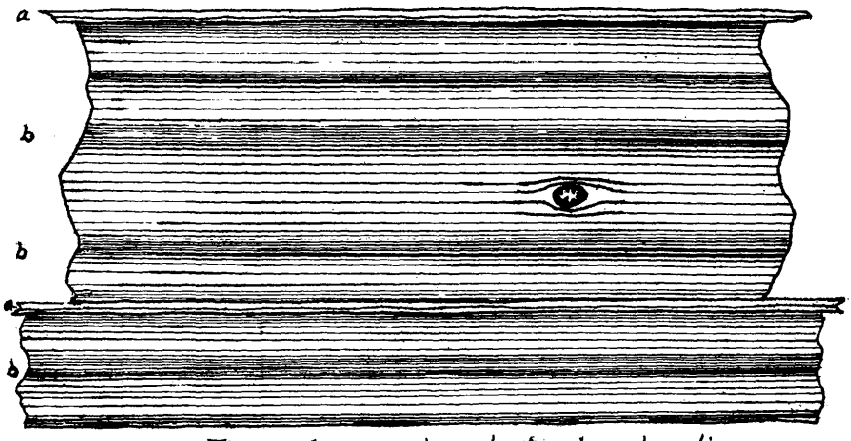

Figure 1. a, carbon sheets; b, carbon lines.

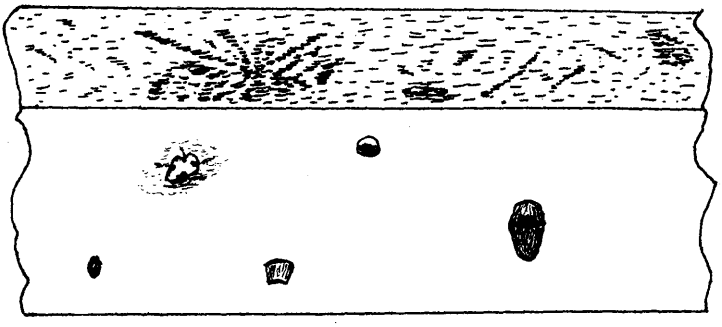

Figure 2.

Figure 3.

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